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CHEMIC

Producers face shrunken market

Page 33

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News of the Week

■ **India sues Carbide in U.S. federal court for damages resulting from Bhopal.** **Page 6**

■ **EPA fines Chemical Waste Management for mishandling PCB wastes.** **Page 7**

■ **Powerful Nova laser dedicated at Lawrence Livermore National Laboratory.** **Page 7**

■ **Carbide buys STP Corp., drops out of Petrosar.** **Page 7**

■ **NSF chooses universities to operate six engineering research centers.** **Page 8**

■ **Du Pont to make oxygen-barrier packaging resin in 50 million lb-per-year unit.** **Page 8**

Business

Former employees of Hoffmann-La Roche fired in a mass layoff in February may file age discrimination lawsuit. **Page 12**

International Business

Association of Petrochemical Producers in Europe established to provide structured, organized voice for the industry. **Page 15**

Government

The budget is top current consideration for Congress; pesticide regulation, chemical weapons program also on agenda. **Page 18**

EPA aims for measurable environmental results, targeting sewage treatment, air and water pollutants initially. **Page 20**

Science

Advisers to UN's International Center for Genetic Engineering & Biotechnology emphasize scientific excellence. **Page 23**

First acetylenic esters synthesized, by researchers at University of Utah, likely to have important chemical properties. **Page 26**

Cover: Photo by William C. Blizzard/Uniphoto Picture Agency, Washington, D.C.

Letters 4
Editor's Page 5

Concentrates
Business 10
Government 17
Science/Technology 21

The Departments
ACS Comment 27
Meetings 63
People 77
Newscripts 92

Product Report

Markets for rubber-processing chemicals are leaner than in the 1970s—smaller cars and tires, a drop in exports, and a rise in imports led to the squeeze. **Page 33**

Age Discrimination Suit Brewing Against Hoffmann-La Roche

Lawsuit stemming from company's February layoff may be filed next month and could be one of the largest age discrimination claims ever

David Webber, C&EN New York

The elimination of at least 1000 positions 10 weeks ago was the first mass layoff in Hoffmann-La Roche's history, and there is little doubt the company would like to put the traumatic event behind it and move on. Whether the increasingly bitter group of former employees will slip easily into Roche's past, however, is another question. It now seems likely that a potentially sizable number of them will charge the company with age discrimination. Many of those terminated are chemists and other technical personnel, but Roche declines to reveal how many.

A number of those affected by the Feb. 4 staff cut (C&EN, Feb. 4, page 7) have formed a group called Roche Age Discriminatees Asking Redress (RADAR) to organize a class-action age discrimination suit against their former employer. The group—open to any of those fired who are over 40 years old—intends to sue Roche for back pay and for whatever difference there is between individual members' future earnings and what their income would have been had the jobs not been eliminated.

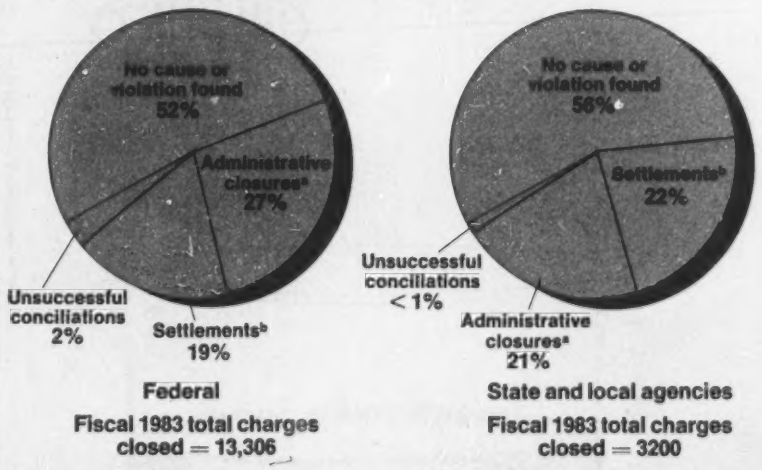
RADAR already has taken the first steps toward such a suit. In March, one member filed an age discrimination complaint in the Newark, N.J., office of the Equal Employment Opportunity Commission (EEOC), the group says. This was done to satisfy a requirement that plaintiffs who want to take their case to federal court first submit their charge to EEOC, a federal government agency, and wait 60 days. A member of RADAR's steering committee says that when that period expires in May, the group will add on the names of other aggrieved former employees and almost certainly file a suit in federal court.

The steering committee member says RADAR believes some 65 to 70%—a disproportionate share—of those dismissed are between 40 and 70 years old, the age group protected by the federal Age Discrimination in Employment Act. Evidence of this is purely anecdotal at this point, however. Terminated employees interviewed by C&EN say that former Roche staff members attending the company's outplacement assistance centers, for example, are overwhelmingly in the over-40 bracket. RADAR expects to obtain data on the age distribution of the mass layoff through the legal process.

Another statistic that might emerge in the legal process is the exact number of those dismissed. Some terminated employees put the total considerably higher than the figure of "approximately 1000" made public by the company. Based on what they say is information from sources remaining in Roche's employ, many of those fired believe that in reality between 1200 and 1600 jobs were eliminated. Roche, in the meantime, refuses to disclose any breakdown of the dismissed group—whether by age, work location, or type of duties—and stands by its rough total of 1000.

Although many of the former employees' charges are little more than guesses at this point, they reflect the depth of anger felt against a former employer once emblematic of a stable work environment. All of those interviewed—managers and

Most age discrimination charges filed in government agencies are unsuccessful


No cause or violation found 52%
Administrative closures[a] 27%
Unsuccessful conciliations 2%
Settlements[b] 19%
Federal
Fiscal 1983 total charges closed = 13,306
No cause or violation found 56%
Settlements[b] 22%
Unsuccessful conciliations < 1%
Administrative closures[a] 21%
State and local agencies
Fiscal 1983 total charges closed = 3200

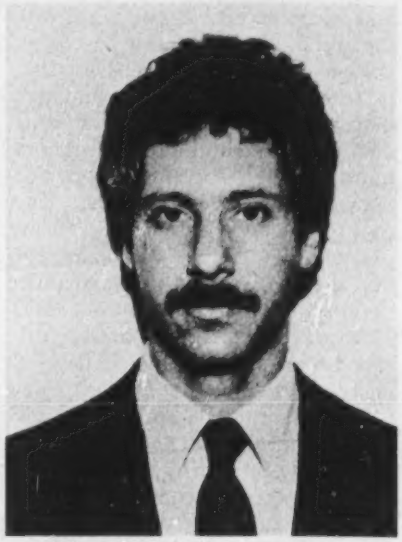
a Unsuccessful negotiated settlements, right to sue invalidated, withdrawal without settlement, and other.
b Negotiated settlements, withdrawals with settlements, conciliations.
Source: Equal Employment Opportunity Commission

chemists with Roche experience ranging from 14 to 28 years and a minimum age of 51—believe they were singled out for dismissal because their salaries, in general, were higher than those of younger employees. They deny Roche's assertion that jobs were eliminated on the basis of superfluity. The pattern of dismissals, they say, was instead generally one of seniority.

There is also dissatisfaction with Roche's severance package. Chemists in the group dismissed, for example, point out that the chief compensation element—one week's pay per year of service—does not meet the guideline for mass layoff severance pay set by the American Chemical Society, which calls for two weeks' pay per year of service. And many complain that the outplacement assistance, though of great help in preparing the résumés of people who have not been in the job market for decades, is not likely to find them new positions at their age.

To date there is no indication of how well the terminated employees are faring in their job searches. A Roche spokeswoman says the company doesn't know; although individual success has been reported, there is no tracking system in place. She says, however, that the career centers have been well attended and that the outplacement assistance personnel "seem quite encouraged."

Many of those dismissed, on the other hand, seem discouraged. Although still looking for jobs and, in many cases, still regarding an age discrimination suit as a last, rather than first, resort, they admit to being more than a little demoralized by the common belief that people over age 55 or so have an extremely difficult time finding employment of equal rank and salary to what they had. They are not cheered by results of a survey published last December by the New York and North Jersey sections of ACS. Of those who responded to a questionnaire mailed to members who had been involved in recent years in a layoff or early retirement, there were, for example, 74 chemists aged 40 or above. Only 28 had found a new job; average time spent finding a new position ranged from seven to 11 months. Only five of 23 in the group over 60 years old found another job.



Cohen: proof is the tough part

Former Roche employees who were interviewed for this article point out that any reluctance they might feel at this point toward joining RADAR's planned lawsuit has little to do with any fundamental aversion to litigation and nothing to do with any vestigial loyalty to Roche. They are worried about blackballing, they say. Some, in fact, are applying for openings at Roche for lower salaries and want to wait until they find out whether they will be rehired or not. And they worry that involvement in a class-action suit could prejudice attempts to find employment with other companies. These fears, whether well grounded or not, are widespread; every terminated employee interviewed requested anonymity.

Ultimately, RADAR expects many if not most of those over 40 who were fired to join the lawsuit. What success they will have with such a suit, on the other hand, seems less certain. Although age discrimination litigation is apparently increasingly common, legal experts say, it remains a difficult charge both to press and to prove.

The basic goal of an age discrimination claim is money to make up for lost wages and either reinstatement in the prior position or money to make up for differences in earning power since losing it. Those who believe they are victims of age discrimination can pursue redress along two general courses: through federal, state, or local government agencies or through private litigation in federal or state courts. Which one they choose—or end up in—has to do with a welter of procedural, legal, and financial considerations.

Because of a recent court ruling, anyone seeking redress in the federal arena must first file a claim with EEOC, the independent body that is charged with handling all types of employment discrimination cases. EEOC then begins investigating the claim, working toward a determination of whether the agency will seek restitution for the claimant.

For an individual claimant, the advantage of letting EEOC handle a case is largely financial. It is possible to pursue the claim without hiring an attorney. On the other hand, the agency has a reputation for inefficacy.

"The problem is simple," says Leonard N. Flamm, partner at Hockert & Flamm, a New York City law firm that specializes in discrimination law. "EEOC is woefully understaffed. There are huge delays, and they only selectively process complaints."

Indeed, in the most recent year for which statistics are available (fiscal 1983), EEOC achieved settlements in fewer than one out of every five cases it disposed of in that 12-month period. The agency found no violation in more than half the cases and closed out nearly all the rest for administrative reasons.

State agencies get slightly higher marks from lawyers in the discrimination law field. In fiscal 1983, for instance, they achieved settlements in a somewhat greater percentage of cases than the federal body did. And, says Arnold S. Cohen, a partner at Oxfeld, Cohen & Blunda, Newark, N.J., speaking specifically of the New Jersey Division of Civil Rights, "they're more inclined to go ahead with a case than EEOC." The reason: relatively better funding.

Still, lawyers say the best avenue is a federal court suit. "All things being equal, a federal lawsuit is far and away the most effective reme-

dy," says V. Pamela Davis, a partner at Lane, Felcher, Kurlander & Fox in New York City. "The federal courts are faster, of better quality, get to trial more quickly, and the damages available under federal law are much greater than those available at EEOC or state court."

Flamm agrees, pointing out that federal courts provide plaintiffs an "indubitable" right to jury trial (nearly always considered an advantage to plaintiffs in such cases), the potential for double damages if "willful" discrimination can be proved, judges more experienced in age discrimination cases, and a greater body of case law.

On the other hand, going to court means hiring a lawyer, a prospect that can be especially daunting to someone who has just lost his or her livelihood. It is thought by many, in fact, that just this aspect discourages most people who would otherwise claim age discrimination. Furthermore, because of the uncertainty involved in such litigation, attorneys are generally unwilling to take a case on a contingency basis. That means a plaintiff must pay hourly rates. And, Flamm notes, it is not always easy to find an experienced discrimination law attorney because of the uncertainty of winning, the likelihood of extensive delaying tactics by the better-funded corporate defense attorneys ("they can deep-pocket the plaintiff's lawyer to the point of exhaustion," he says), and because discrimination law is complicated and little taught in law school.

In an age discrimination trial, a plaintiff has to prove first that he or she was fired despite being qualified. At that point, the defendant employer then has the burden of proving that there was a nonage-related business reason for the termination such as an economically motivated job cutback or lack of performance by the plaintiff. It is then up to the plaintiff to show that the defendant's declared rationale was a pretext. "That's the really tough part," says Cohen.

"The biggest problem is proving age discrimination," agrees Davis of Lane, Felcher. "It's getting harder and harder to prove, because employers are much more aware of it and more careful about what they say and do."

Not only are employers less likely now to say anything blatantly discriminatory about older staff, many have instituted more frequent, more heavily documented performance reviews. For employers, a series of reviews showing declining productivity can be powerful evidence in court. It is not a sure-fire defense, however. In some cases, plaintiffs have argued successfully that reviews were skewed to mask an age-motivated layoff.

By and large, discrimination lawyers do not believe that companies are merely becoming cannier about cloaking age discrimination. They think that, because of both greater awareness of the issue and the threat of financial penalty, most are less likely to discriminate now either intentionally or by blunder. Still, at the same time that actual age discrimination may be diminishing, lawyers are receiving an increasing number of such cases. This growth is probably a function of several concurrent developments: the many mass layoffs of recent years, greater knowledge by employees of their legal rights, a gradually accumulating record of courtroom success, and a more favorable judicial climate for plaintiffs.

A half-dozen years ago, comments Flamm, age discrimination suits elicited a "general judicial distaste." Judges typically considered plaintiffs malcontents and their suits logjams in the court calendar, he says. The increasing number of cases, however, has convinced the judiciary that such suits are here to stay, Flamm says, and has resulted in a greater tolerance of the suits.

This trend has helped plaintiffs' lawyers raise the importance of front pay as a compensatory addition to back pay, the traditional award in age discrimination suits. Customarily in the past, employers losing in court were ordered to offer the former employee reinstatement in his or her former position. Psychologically, however, this solution to the problem of future earnings was always fraught with complication. Recently, therefore, courts have become more receptive to the front pay alternative, typically bringing in employment compensation experts to calculate the difference between what a plaintiff would have made in a prior job and what will be earned elsewhere.

In addition, Flamm points out, the class-action age discrimination suit—like the one being planned by RADAR—is growing more common. The explosion of mass layoffs since the mid-1970s has created more groups of former employees with common grievances. Also, a class-action approach has a simple advantage for claimants: It greatly reduces each individual's legal cost.

Like most litigation, Flamm says, "the overwhelming number of age discrimination cases get settled" somewhere between the courthouse steps and the judge's chambers. Judges, he says, have become increasingly ready to pressure the two sides into a settlement to avoid trying such cases, which are typically long and drawn out.

There is a good reason many a plaintiff settles: It may be his or her best shot at any compensation at all. "If you consider a settlement a win, then you win more than half the time," says Cohen of Oxfeld, Cohen. "When you go to trial, you prevail probably less than 50% of the time."

All the difficulties of pressing an age discrimination suit might have been more discouraging to the former Roche staff members did they not have an example of success taken from familiar surroundings. This is Erwin Klingsberg, whose age discrimination suit settlement against his former employer, American Cyanamid, seems to be known by everyone let go by Roche. Klingsberg, fired at age 60 in 1981 after refusing an early retirement offer, settled with Cyanamid this January for a "low six-figure sum." Through each stage of his case and since, he has been a passionate advocate of the rights of older employees, arguing that age discrimination is an issue that, because of employee fears and confidentiality provisions, has been unexposed for too long.

"It's an absolute fact that companies are violating the law," he asserts. "It's just a matter of firing an old guy. These companies think they can get away with murder." □

Rubber Chemicals Face Smaller Market

Uniroyal technician carves new tread design on a blank tire

Stephen C. Stinson, C&EN New York

As the U.S. rubber industry resumes normal growth after a long recession in the early 1980s, U.S. suppliers of organic rubber-processing chemicals find themselves doing business in a world that looks very different from that of the 1970s.

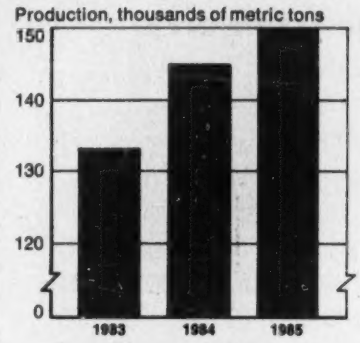
First, restructuring of the automotive and tire industries, which consume 65 to 75% of all rubber in this country, has much reduced the domestic market for these chemicals. Even if there are no further recessions, the projected 2% annual growth will take until the late 1990s before U.S. production of rubber-processing chemicals reaches the prerecession high of 180,000 metric tons in 1979.

Second, continuing strength of the dollar makes the U.S. market vulnerable to imports, while threatening the traditionally strong export trade. Moreover, plant capacity use among foreign producers of rubber-processing chemicals is lower than in the U.S., making this country attractive to redoubled sales efforts. Imports have grown steadily over the past decade and could reach 13,000 metric tons in 1985, which is 9% of consumption. Exports have risen and fallen with the world economy and may continue at more than 21,000 metric tons this year, which is 14% of production.

Overall, the 20 or so U.S. producers can look forward to making 150,000 tons of organic rubber-processing chemicals in 1985, valued at $525 million. This represents a 3% increase over 1984 levels, which in turn were almost 10% greater than in 1983.

One indication of the complexity of this industry is that production will be spread out over about 125 different chemicals. Another indication of complexity is that in addition to large sales to a dozen domestic tire companies, the industry also will service the needs of hun-

Organic rubber-processing chemicals at a glance



Uses: Accelerators, activators, and vulcanizing agents 26%; antioxidants, antiozonants, and stabilizers 58%; other 16%

Foreign trade: Exports, 14% of production. Imports, 9% of consumption

Prices: Average $1.59 per lb

Commercial value: $525 million for 1985 U.S. production

dreds of manufacturers of nontire rubber goods.

Illustrative of the specialized nature of the industry is that if the 125 organic rubber-processing chemicals were all one substance, the volume would not be great enough to make C&EN's list of the Top 50 Chemicals, ranked by volume produced. Alternatively, if one company sold that dollar amount as its sole business, that firm would be 59th among chemical producers ranked by chemical sales. According to the International Trade Commission, 86 of these rubber-processing chemicals have only one U.S. producer each, 24 chemicals have only two producers, 12 have three producers, two have four producers, and only one is made by as many as five companies.

But the changes of the 1970s have taken their toll on the domestic rubber-processing chemical industry. For 1983, the last year for which data are available, the International Trade Commission listed 125 chemicals in this category, produced in the U.S. by 21 companies. In 1973, by contrast, ITC listed 166 chemicals made by 30 firms.

The restructuring of the auto, rubber, and processing chemical industries began in 1973 with the escalation of oil prices. As feedstock prices tripled, one of the first effects was that natural rubber became more competitive against synthetic rubber for the first time since World War II.

Natural rubber contains its own antioxidant substances to protect it during fabrication. Increasing use of natural rubber thus reduces the market for antioxidant stabilizers. In contrast with synthetics, however, natural rubber needs peptizers to reduce viscosity for ease of fabrication. Natural rubber had sunk to 22% of total U.S. rubber consumption in 1973 but has since drifted up to about 27% of total use.

Latex rubber mixture is checked for impurities by Goodyear researcher

A second effect that added to consumption of natural rubber and changed the mix of rubber-processing chemicals was the introduction of radial tires in the mid-1970s. Tire makers use more natural rubber to make radials because of its lower heat buildup during driving. The longer-lasting radial tire also has reduced the market for replacement tires, and with it the total market for rubber-processing chemicals. Replacement tires are about 75% of total tire sales. Though radial tires are expected to capture 90% of the U.S. market by 1990, makers of rubber-processing chemicals have largely absorbed their impact.

A bright side to the advent of long-lasting radials is that they need more antioxidants and antiozonants to protect them in service. This is because even when standing still, such tires will be exposed to degrading effects of atmospheric oxygen and ozone for more years than once-conventional bias-ply tires.

Rubber-processing chemicals: a definition

The rubber-processing chemicals described in this report are the 200-odd organic substances that rubber compounders use to make vulcanized rubber products. With the exception of such goods as crepe rubber shoe soles and adhesives, raw rubber has no commercial uses. It must be extensively compounded first with specialty chemicals.

This report covers accelerators to speed the crosslinking reaction with sulfur, activators to potentiate the accelerators (sometimes called secondary accelerators), retarders to delay vulcanization, organic sulfur donors and peroxides as vulcanizing agents, peptizers for viscosity reduction, and antioxidants and antiozonants to protect rubber in processing and afterwards in use. Rubber compounders use an average of 4.5 lb of these chemicals per 100 lb of raw rubber.

Organic compounds not treated in this report include mercaptans that regulate polymerization of monomers to raw rubber, peroxides that initiate such polymerization, fatty acid activators, and various oils used as physical plasticizers and extenders.

Among inorganic substances excluded in this report are elemental sulfur as vulcanizing agent, zinc oxide and other oxide activators, and carbon black, alkaline earth carbonate, silica, and clay reinforcements and fillers.

Rubber-processing chemical output begins slow climb back

Thousands of metric tons	1979[a]	1982[b]	1983[c]	1984
Accelerators, activators & vulcanizers	66.7	32.9	34.9	38.3
Thiazoles	49.4	28.0	28.6	31.6
2,2'-Dithiobis(benzothiazole)	7.5	3.1	4.0	4.4
Dithiocarbamates	4.9	2.3	2.8	2.7
Others[d]	8.4	2.6	3.7	4.0
Antioxidants, antiozonants & stabilizers	86.0	39.9	76.7	85.1
Amine compounds[e]	53.8	39.5	47.9	52.3
p-Phenylenediamines	28.7	24.1	29.5	31.7
Phenolics & phosphites	32.2	20.[illegible]	28.8	32.8
Others[f]	32.8	12.1	21.2	23.1
TOTAL	178.2	104.2	132.8	148.5

a All-time high. b Bottom year of recession. c Latest year for which data are available. d Includes aldehyde-amine adducts, guanidines, thiurams, xanthates, and sulfides. e Includes aldehyde- and acetone-amine adducts. f Includes blowing agents, peptizers, and polymerization regulators. Sources: U.S. International Trade Commission, C&EN estimates

Rubber chemicals:

Three tire firms have more than half of the business . . .

B. F. Goodrich
Goodyear Tire & Rubber
Uniroyal

. . . and 18 other companies share the remainder

Alco Chemical
American Cyanamid
Borg-Warner
Du Pont
Ferro
Fike Chemicals
Hexcel
ICI Americas
Kenrich Petrochemicals
Monsanto
Neville Chemical
Olin
Pennwalt
Phillips Petroleum
Reichhold Chemicals
Signal UOP
Vanderbilt
Westvaco

Source: International Trade Commission

A third effect of rising oil prices has been a reduction in car sizes to improve mileage and lower costs. This "downsizing" also has decreased tire sizes and reduced the total amount of nontire rubber use in cars. The rubber-processing chemical industry may absorb the effects of downsizing by 1990.

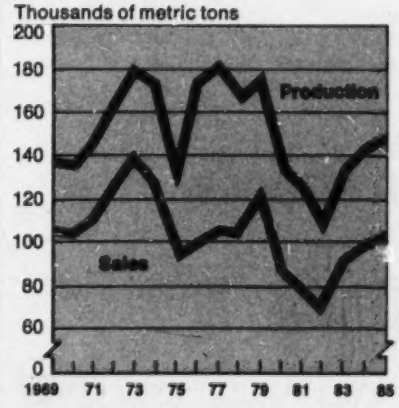
The net effect of all these changes of the 1970s is that although the rubber-processing chemical industry has recovered from the one long recession that began for it in 1979, recovery has leveled off at a lower volume. Compounding the problems of a contracted, slow-growth market is the rising tide of imports. Joseph B. Eisenberg, rubber chemicals marketing manager for Uniroyal, estimates that capacity use is only 70% worldwide, compared with 85% in the U.S. This situation stimulates foreign producers to export to this country.

Production and sales of rubber-processing chemicals in the U.S. is a complex mosaic of arrangements. For example, companies like Monsanto produce for the merchant market. Vanderbilt both produces its own chemicals and distributes those of others. Mobay imports most of its chemicals from its parent, Bayer of West Germany, while steadily expanding production in the U.S. Three rubber companies—B. F. Goodrich, Goodyear, and Uniroyal—produce for their own captive needs and sell on the merchant market.

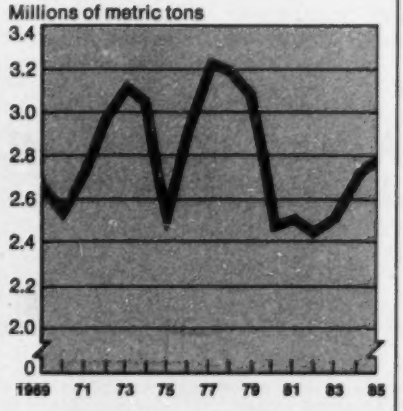
This complex state of affairs makes it hard to ascertain the share of domestic production of each company. One person who has studied the U.S. rubber-processing chemical market is Melvin M. Schlechter, an analyst with the consulting firm of Frost & Sullivan, New York City. Working with Schlechter's figures, C&EN has determined that Monsanto is the leader, with 1985 production in the U.S. of about 50,000 metric tons, worth $170 million. Goodyear Tire & Rubber is second with about 42,000 metric tons, worth $145 million. Of this amount, Goodyear uses about 27,000 metric tons captively and sells the rest. In third place is Goodrich, which produces about 20,000 metric tons, worth $68 million. Goodrich uses about 10,000 metric tons captively and sells the rest.

Nearly tied with Goodrich, Uniroyal produces about 19,000 metric tons, worth $67 million, of which the company uses about 10,000 met-

Rubber chemicals market has contracted . . .



. . . matching reduced rubber consumption



Sources: International Trade Commission, Rubber Manufacturers Association, C&EN estimates

Glossary of rubber terms

Accelerator. Speeds crosslinking of rubber by sulfur. Example: 2,2′-dithiobis(benzothiazole).

Activator. Renders accelerators more potent. Example: zinc oxide with stearic acid. Alternatively, a secondary accelerator that is an accelerator in its own right but is more often used with others. Examples: thiurams, dithiocarbamates, and guanidines.

Antioxidant. Protects cured rubber products against oxidative degradation in service. Examples: *N*-isopropyl-*N*′-phenyl-*p*-phenylenediamine, which is also an antiozonant, and octylated diphenylamine, which is not. Antioxidants that protect synthetic rubbers from production through processing are called stabilizers.

Antiozonant. Protects cured rubber products against ozone. Examples: waxes, which migrate to the surface to form a physical barrier, and *N*,*N*′-bis (1,4 - dimethylpentyl) - 1,4 - phenylenediamine, which protects by chemical reaction.

Blooming. Unwanted migration of substances like sulfur to rubber surfaces to produce discoloration.

Bonding agent. Enhances rubber adhesion to fabric or fiber. Example: resorcinol plus hexamethylenediamine.

Cure. Crosslinking of rubber polymer chains to impart elastomeric properties. Also called vulcanization.

Cure time. Time needed for rubber compounds to reach maximum viscosity or modulus at a given temperature; the sum of the scorch time and crosslinking time.

Hard rubber. Rubber cured with 15 to 40% of added sulfur.

Latex. Water emulsion of rubber polymer, used as is for coating or dewatered for making solid parts.

Lubricant. Eases flowing of rubber in molding or extrusion.

Mastication. Preliminary physical and chemical breakdown, usually of natural rubber, in a mill or mixer to reduce viscosity for further processing.

Peptizer. Promotes chemical breakdown of rubber during mastication; also called plasticizer. Example: pentachlorothiophenol.

Phr. Parts-per-hundred rubber; the number of parts by weight of substance added to 100 parts of rubber.

Plasticizer. A peptizer, an oil, a monomeric ester softener, or an extender. Example: bis(butoxyethoxyethyl) glutarate.

Retarder. Lengthens time before onset of curing. Example: phthalic anhydride. Sulfenamide-type retarders have acquired the separate name of prevulcanization inhibitors. Example: *N*-cyclohexylthiophthalimide.

Reversion. Decrease in rubber modulus or viscosity caused by overworking.

Scorch. Premature curing.

Scorch time. Safety margin of time that a rubber compound can be worked at a given temperature before curing begins.

Soft rubber. Rubber cured with 0.5 to 8% of added sulfur.

Stabilizer. Antioxidant that protects rubber from polymerization through curing. Example: tris(nonylphenyl) phosphite.

Staining. Blue or purple coloration of rubber surfaces due to oxidation of *p*-phenylenediamine-type antioxidants and antiozonants.

Sulfur donor. Organic polysulfide that replaces some elemental sulfur in rubber compounds and promotes curing mostly by monosulfide crosslinks in a process called ef[illegible] vulcanization. Example: tetramethyldithiuram disulfide.

Vulcanizing agent. Cures rubber by forming crosslinks among polymer chains. Examples: sulfur, organic peroxides, and phenolic resins.

ric tons captively and sells the rest. Mobay Chemical produces some 16,000 metric tons, worth $57 million. And R. T. Vanderbilt produces about 2000 metric tons, worth $6 million.

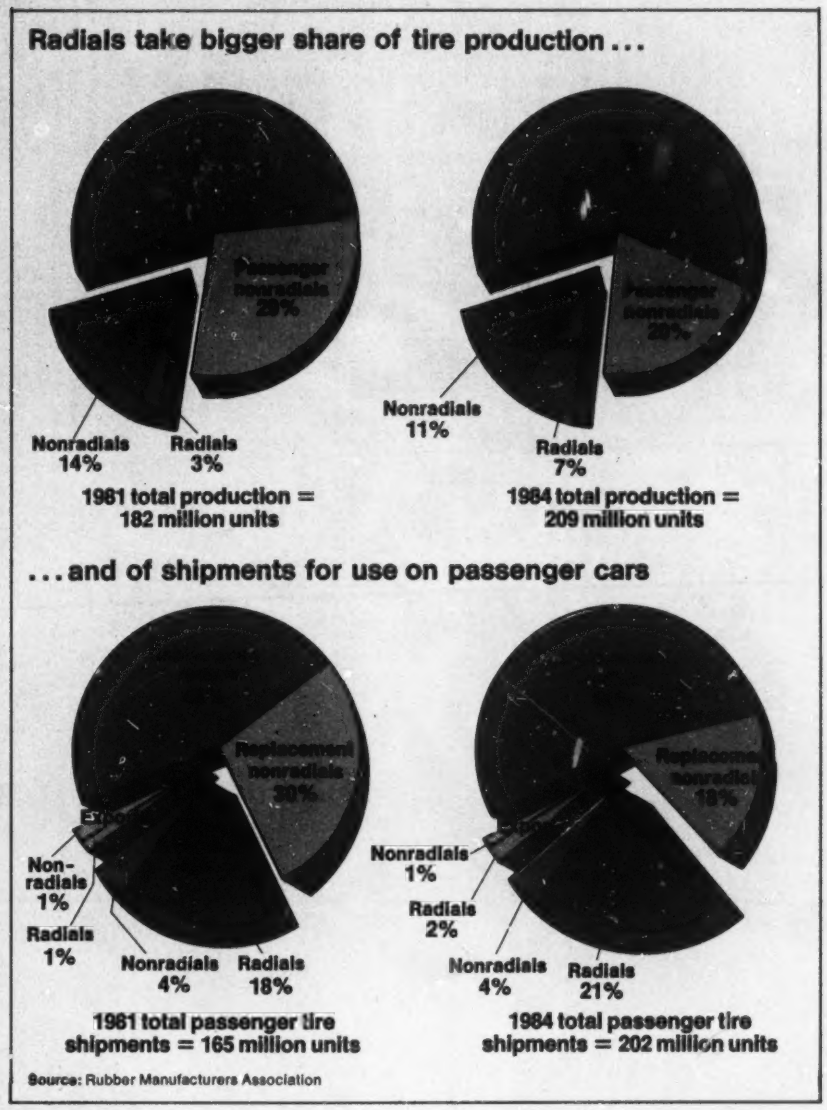
As Schlechter's study for Frost & Sullivan indicates, the sales situation is more complex still. For example, Monsanto sells directly to tire companies, but tends to use Harwick Chemical Co. of Akron and other distributors to the nontire market. Harwick sells some 11,000 metric tons of Monsanto's chemicals, valued at $40 million.

Again, under longstanding agreements with both companies, Vander-

Synthetic rubber output rose in past two years, but remained well below levels of 1970s

Thousands of metric tons	Production											Annual change	
	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1983–84	1974–84
Styrene-butadiene rubber[a]	968	904	876	1032	1074	1378	1395	1395	1333	1179	1466	8%	−4%
Polybutadiene	359	333	268	342	311	397	378	361	352	290	310	8	1
Nitrile	67	55	46	66	63	76	73	70	73	55	68	22	−3
Ethylene-propylene	215	175	123	178	144	175	174	158	130	84	126	23	5
Polychloroprene	130	115	119	143	151	183	161	185	166	144	183	13	−2
Other[b]	365[c]	353[c]	379[c]	281	272	326	292	287	250	188	345	3	0
TOTAL	2095	1935	1830	2022	2015	2534	2473	2418	2103	1840	2498	8%	−2%

a Excludes high-styrene latex (more than 45% styrene). b Includes butyl, polyisoprene, silicone, and other synthetic elastomers. Excludes polyurethane rubber. c Values are partly estimated. Source: Rubber Manufacturers Association



bilt sells the accelerator chemicals of Goodyear and the antioxidants and antiozonants of Goodrich. Thus Vanderbilt's total sales of rubber-processing chemicals hover around 7000 metric tons, worth $30 million. Goodyear sells its own antioxidants and antiozonants. Goodrich markets its accelerators through such other distributors as H. M. Royal of Trenton, N.J., and Akron Chemical Co.

Distributor companies also import rubber-processing chemicals. One such firm is Prochimie of New York City, which represents UCB of Brussels, Belgium, and Manufacture Landaise de Produits Chimiques of Rion-des-Landes, France. It also sells the tetramethylthiuram disulfide and zinc dimethyldithiocarbamate of UCB Chemicals in Bucks, Ala. A second such firm is Cook Chemical Co. of Akron, which imports a wide line of rubber-processing chemicals from Vulnax International in France.

Schlechter points out in his study that imports of these chemicals are hard to analyze because of a lack of product breakouts by the U.S. Bureau of the Census. He also cites errors of classification, duplication, and nomenclature in import data of the International Trade Commission. Schlechter has reanalyzed ITC data and constructed uniform import tables, which also show which U.S. companies are domestic producers of each compound.

Illustrating the value of such tables, he says, "For imports of benzothiazole accelerators under dibenzothiazyl disulfide, it would appear that Mobay, Pennwalt, and Cook Chemical are the major importers, because Uniroyal and Monsanto are U.S. producers. R. T. Vanderbilt either buys domestically or imports."

Noting that dibenzothiazyl disulfide is produced by Mobay in West Germany, Pennwalt in Italy, and Vulnax International in France and the U.K., Schlechter says, "Further information on the country of origin would quantify the individual volumes imported by Mobay, Pennwalt, and Cook Chemical in our example, because West Germany, Italy, and France/U.K. would be the respective exporting countries for these companies." The *New York Journal of Commerce* compiles information on amounts and countries of origin of individual chemicals as a service to which people can subscribe.

One of the ways in which U.S. producers plan to compete in the changed market for rubber chemicals is introduction of new products. At Monsanto, for example, commercial development manager Edwin L. Kaiser says the company has introduced hexakis(isopropylthio)melamine as a prevulcanization inhibitor to retard onset of curing. This multifunctional compound is more potent, more compatible with rubber, and works with a wider variety of accelerators than the cyclohexylthiophthalimide Monsanto had previously discovered. The company supplies it mixed with an inert diluent so that compounders can weigh it more accurately.

Also new to Monsanto are sodium and nickel salts of hexamethylene dithiosulfate as what the company calls prevulcanization stabilizers. Such compounds repair shear and thermal damage to rubber polymer chains from overworking by forming new crosslinks. Both chemicals also act as adhesion promoters of rubber to brass-coated steel tire cord, Kaiser notes, in which the nickel salt excels.

These two new compounds also are examples of developments from the worldwide network of Monsanto's research labs that the firm can draw on. Kaiser says the two organo-

thiosulfates were invented at the laboratory of Monsanto Europe in Louvain-le-Neuve near Brussels. Though a part of a different Monsanto company, Kaiser says, "the Belgian lab cooperates closely in work for the Akron laboratory. Because the tire and other rubber industries are worldwide industries, we try to maintain Monsanto rubber chemicals as a worldwide entity, working within subsidiary companies."

Another advantage that Monsanto has in competing in the rubber-processing chemicals industry, Kaiser says, is the company's testing instrument business. "Instruments help us to sell chemicals and also to perceive the needs of the industry." In this connection, he says that the Akron laboratory recently has developed a moving die rheometer that may replace the oscillating disk rheometer, which Monsanto also invented and which has become standard in the rubber industry. Another new Monsanto instrument developed at Akron is a tensile strength tester.

Kaiser says that Monsanto's future efforts will focus on improved antiozonants to protect radial tires during their relatively longer lifetime and as radials evolve toward thinner sidewalls. The company will also work on chemicals with wider processing latitude for automated tire building plants.

At Goodyear, product manager Larry Keller says that the company has introduced the di-β-undecylthiopropionate ester of tetraethylene glycol as a synergist for stabilizers to prolong their antioxidant properties through the vulcanization process. Data so far indicate that the compound works well with phenolic antioxidants in carboxylate latexes. There are also preliminary good results with phenylenediamine-type antioxidants in other rubbers.

In its quest for new products, Keller says that Goodyear has a strong program in place to research new antioxidants. Product aims include ever increasing potency at lower cost.

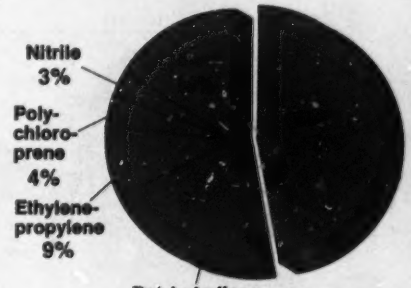
At Uniroyal, Robert Mazaika, vice president of the chemicals and polymers division, says that the company has developed a delayed-action accelerator, *N*-dimethylthiocarbamylthio-*N'*-phenylurea. The compound avoids use of morpholine, which has been criticized because of toxicity. Mazaika says the compound contributes good dynamic modulus for enhanced tire rolling resistance. Managers are uncertain whether it will become a general or specialty product, however.

Uniroyal's research efforts concentrate on nonstaining antiozonants. Staining is the appearance of a blue or purple film of reacted additive on rubber surfaces. Mazaika says the company will work on both monomolecular antiozonants and altered rubber polymers as approaches to the problem. He notes that ethylene-propylene-diene monomer (EPDM) rubber resists ozone attack, and one solution could be uniform covulcanization of EPDM and styrene-butadiene rubber (SBR) in sidewalls. Staining would be particularly unsightly on white sidewalls, but Mazaika sees the problem extending to black sidewalls as many tire companies introduce cosmetic black sidewalls to their top-of-the-line products.

Research at Uniroyal also focuses on diffusion rates of monomolecular antiozonants. This is because one key to long-term protection of radial tires is continuous, controlled diffusion of additive to the surface.

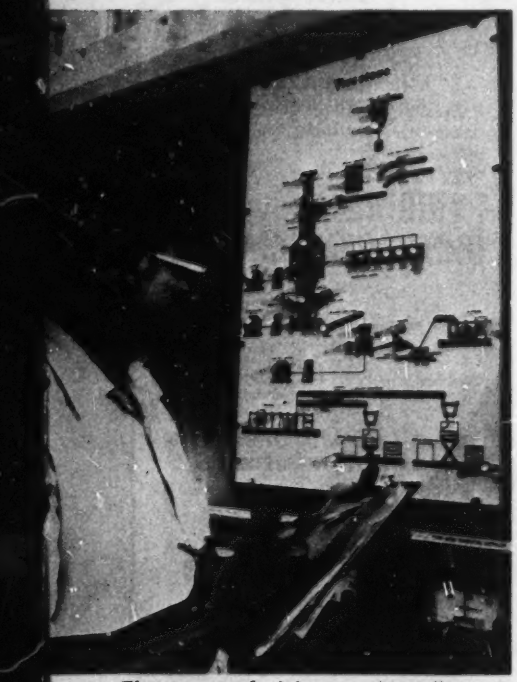
Researchers at American Cyanamid also are interested in adhesion promoters for radial tires, says marketing manager William Bush. The company recently introduced a resin powder concentrate to meet this need. According to Bush, Cyanamid's competitive stance is "to reduce our product line to those where

SBR remains most widely used synthetic rubber

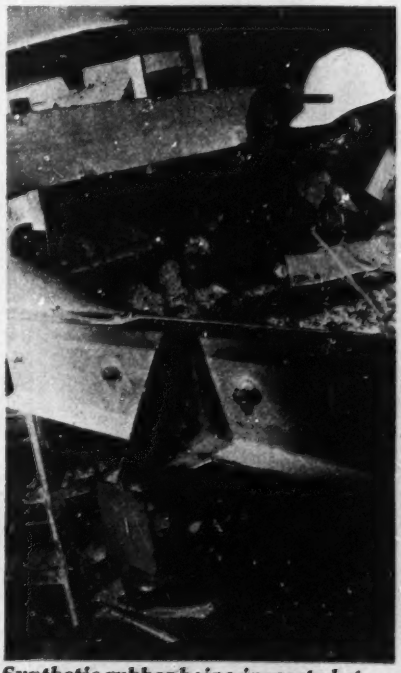


1984 U.S. consumption = 1.98 million metric tons

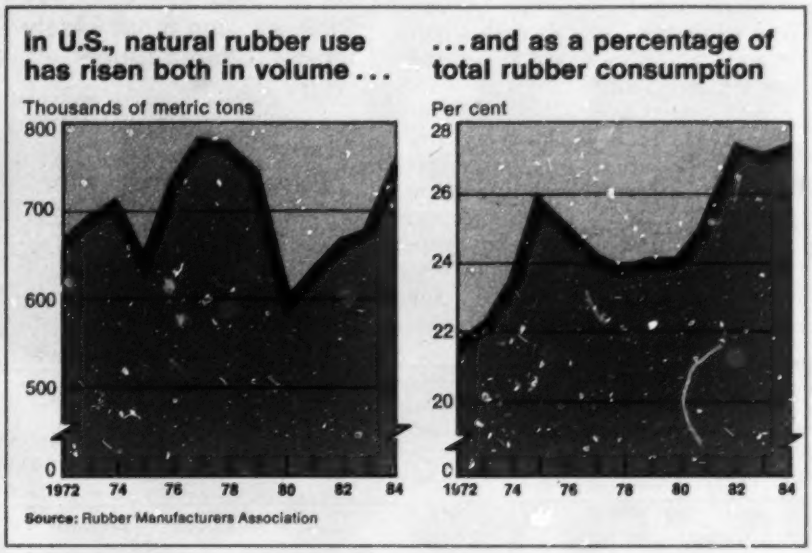
a Styrene-butadiene rubber. b Includes butyl, polyisoprene, and silicone rubbers.
Source: Rubber Manufacturers Association



Firestone technician monitors flow of material through mixing operation



Synthetic rubber being inspected at Goodyear's Houston plant



we are basic and to manufacture in-house. Our research is geared to reinforce this idea and to develop new products in those areas."

For this reason, the company withdrew from low-profit benzothiazole and sulfenamide accelerators in 1982, and now concentrates on adhesion promoters, antioxidants, peptizers, guanidines, and vulcanized vegetable oils. "We think this was a correct decision," Bush says. "The business has been successful since then—very good."

Mobay's recent activities center on U.S. introduction of chemicals already made by Bayer in West Germany and on expansion of U.S. production. A. M. Gabriel, director of the rubber department within Mobay's organic and rubber chemicals division, says that the company has introduced the accelerator morpholinobenzothiazole accelerator here. The firm has also added three phenylenediamine-type antioxidants to production at its plant in Bushy Park, S.C.

Gabriel notes that there is constant interest in the rubber industry in accelerators that delay vulcanization for processing safety but that also give fast cures once vulcanization begins. In this connection, Gabriel says that several customers have asked Mobay to reintroduce *N*, *N*′-dimethyl - *N*, *N*′-diphenylthiuram disulfide. This secondary accelerator potentiates the effects of

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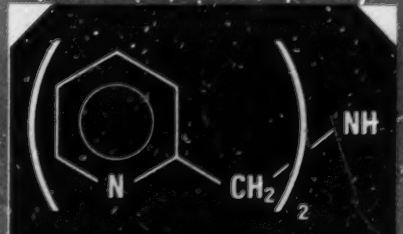

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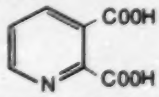

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Columbus also discovered rubber

Rubber has taken five centuries to reach its current sophisticated level of technology using a host of organic processing chemicals. A true New World product, rubber may first have been noticed by Columbus. The Germans pioneered synthetic rubber in World War I, and synthetic rubber today accounts for two thirds of worldwide use. Following is a chronology of rubber's recorded history.

1496. In what may be the first mention of rubber, Michele de Cuneo returns from Columbus' second voyage and writes that in Hispaniola, "There are also trees that when cut give milk, of which [the Indians] make something like wax, and we have tried it out."

1521. Hernando Cortez sees the Aztecs of Mexico using a gum from trees to waterproof utensils and make balls for games. Spanish colonists also use the gum for waterproofing, but for the next 300 years, it appears in Europe only as balls and other curiosities.

1750. After a 14-year search in South American jungles, engineer François Fresneau finds the rubber tree, *Hevea brasiliensis*. Astronomer Charles de la Condamine reads Fresneau's paper to the French Academy, using the Indian word caoutchouc for the gum, derived from caa (tears) and ochu (wood).

1770. Joseph Priestley writes that the gum makes a good "rubber" to erase pencil marks, but he is probably not the first to use the word.

1819. With the development of solvent processing by English inventor Thomas Hancock, manufacture of rubber articles begins in England. Products eventually include the raincoat of Charles Macintosh (1823) and waterproof shoes. Hancock also builds a machine that renders rubber more masticable, thus inventing mastication. Still, rubber goods are inferior, becoming sticky in summer and brittle in winter.

1839. Charles Goodyear accidentally finds that heat cures a compound of rubber, sulfur, and lead carbonate to a hard, resilient, infusible solid. Hancock discovers the process independently and coins the term vulcanization. Goodyear gets a patent, U.S. 3633, June 15, 1844.

1876. Coffee planter Henry Wickham smuggles 70,000 Hevea nuts out of Brazil, which until now has had a monopoly on world rubber production. The British send 3000 seedlings grown in Kew Gardens, London, to start plantations in Ceylon, Malaya, and Singapore. By 1900, plantings reach 4000 acres in those lands.

1888. Veterinarian John Boyd Dunlop makes pneumatic tires for bicycles. Extension of this idea to automobile tires will make the fortunes of both the rubber and auto industries.

1906. Chemist George Oensager at Diamond Rubber Co., Akron, discovers that aniline accelerates vulcanization. Though abandoned as too toxic, this compound becomes the first in a long line of organic accelerators commercialized in coming decades.

1910. Recent invention of the automobile stimulates production of 94,000 tons per year of rubber as prices skyrocket to $3.12 per lb. Chemistry professor Carl Dietrich Harries at the University of Kiel, Germany, discovers that sodium catalyzes polymerization of 2,3-dimethylbutadiene to a synthetic "methyl rubber."

1918. By the end of World War I, Germany has produced a total of 2350 tons of methyl rubber.

1927. German chemists develop Buna S (butadien-natrium-styren) rubber, spearheaded by work of chemistry professor Karl Ziegler at Heidelberg University. German patents also appear on rubbers made by reactions of di- and trichloroalkanes with alkali polysulfides.

1931. Du Pont announces neoprene, a synthetic rubber made from chloroprene, whose commercial synthesis has been developed by Wallace H. Carothers.

1942. Cut off from supplies of natural rubber, the U.S. government orders the planting of 75,000 acres of the guayule shrub. After World War II, work on guayule rubber will be abandoned. U.S. industry gears up to produce various synthetic rubbers, which will reach 700,000 tons in 1945.

1955. Studies of tire cracking in the smog-laden atmosphere of Los Angeles implicate ozone as the cause, which leads to use of organic antiozonants in rubber compounds.

1973. U.S. consumption of natural rubber has bottomed out at 22% of all rubber used here. But now the Arab oil embargo and steep rises in oil prices set off a series of price increases in feedstocks that throughout the decade tilt the balance against synthetic rubber.

1985. World rubber production is 13.7 million tons this year, of which 32% is natural. The U.S. consumes 2.8 million tons, 28% of it natural. To fabricate this amount of rubber, the U.S. uses 150,000 tons of organic rubber-processing chemicals.

other accelerators and yields safe, fast cures at relatively low temperatures.

The contribution of C. P. Hall Co. to the industry is a line of ester physical plasticizers. To rubber compounders, plasticizers are of two kinds. One is a class called peptizers, which reduce viscosity of natural rubber by chemical change. The other class consists of oil and ester physical softeners and extenders. New products at C. P. Hall include two glutarate polyesters, a trinonyl trimellitate, and a trinonyl glutarate. All of these plasticizers are designed to promote good low-temperature properties in nitrile, polychloroprene and chlorosulfonated polyethylene rubbers. The polyesters resist extraction, volatilization during processing, and weathering, and enhance plasticizing efficiency. Company spokesmen say the branched nonyl monomolecular esters are more economical, compatible, and efficient than competing glutarates and trimellitates, and yield better low-temperature properties.

Pennwalt's Lucidol division in Buffalo, N.Y., has intensified its marketing of peroxide vulcanizing agents to the rubber industry. Peroxides are more expensive than the elemental sulfur and not widely used. They are also incompatible

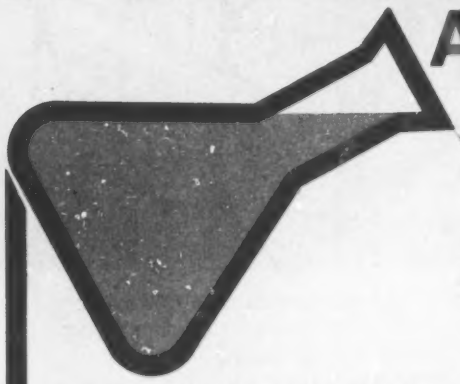
Radial tires pour from curing presses at Goodyear's Topeka, Kan., plant

with most antiozonants and phenolic and phenylenediamine-type antioxidants. This is because amines and phenols trap free radicals. Nevertheless, peroxides yield rubber goods that have superior heat aging, resilience, color, and odor, and they crosslink saturated as well as unsaturated polymers to elastomers. The most important such peroxide for rubber vulcanization probably is dicumyl peroxide.

One new technology where peroxides find use is covulcanization. For example, Lucidol spokesmen say that a blend of 75% polyethylene and 25% EPDM can be cured to homogeneous wire insulation that has corona resistance, cure rates, hot modulus, and flexibility that are superior to crosslinked polyethylene. Peroxide curing of the same resin blend also produces heat-shrinkable tubing, gaskets, and belts.

Schiechter of Frost & Sullivan notes that some firms serve the rubber industry that make no effort to

Additives from A to Z



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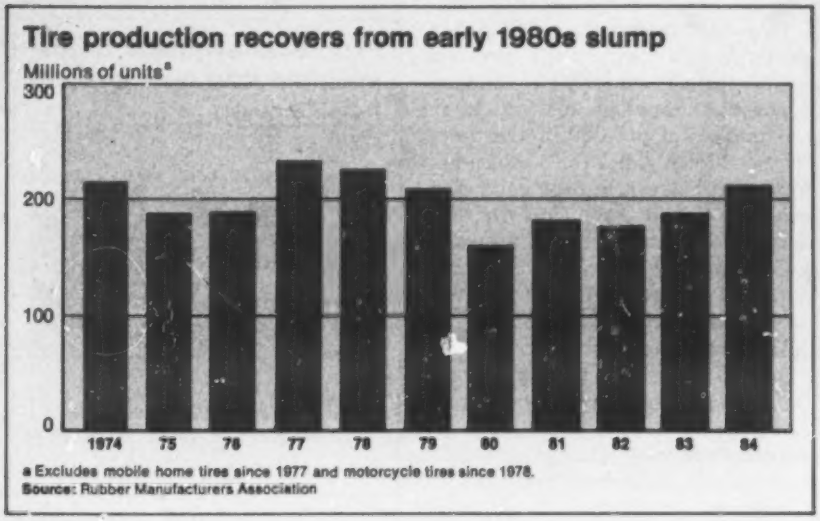

field complete lines of processing chemicals. He cites Borg-Warner, which makes about 20 organophosphate antioxidants and sells some of them to rubber compounders in addition to its major sales to the plastics industry. Du Pont and Reichhold view their participation in the rubber industry with styrenated phenol antioxidants as adjuncts to their roles in the plastics industry, Schlechter says. And Signal UOP's phenylenediamines are used mostly as gasoline additives.

In addition to marketing new products, producers of rubber-processing chemicals improve their competitive stances by production in many parts of the world. As already noted, Mobay in the U.S. and Bayer in Europe have such production networks. Monsanto produces at 13 plants in nine countries. And Uniroyal has nine plants in seven countries. For such major producers, location of plants in many countries is part of their view of rubber-processing chemicals as a worldwide industry. For such firms as Pennwalt—whose organic chemicals division has shifted much of its accelerator production to Termoli, Italy—or Vanderbilt, which has a new joint venture, Artivi, near Mexico City, such moves may reflect a desire to lower production costs to compete better in the U.S. as well as elsewhere.

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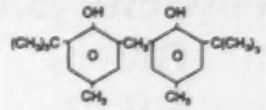
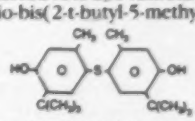
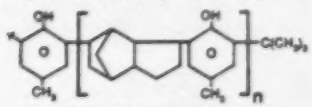


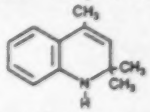
ULTRANOX 236 Antioxidant
4,4'-thio-bis(2-t-butyl-5-methylphenol)



ULTRANOX 256 Antioxidant
Polymeric sterically hindered phenol



ULTRANOX 254 Antioxidant
Polymeric 2,2,4-trimethyl-1, 2-dihydroquinoline



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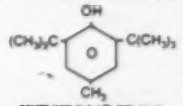
2,6 di-t-butyl-4-methylphenol



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CIRCLE 44 ON READER SERVICE CARD

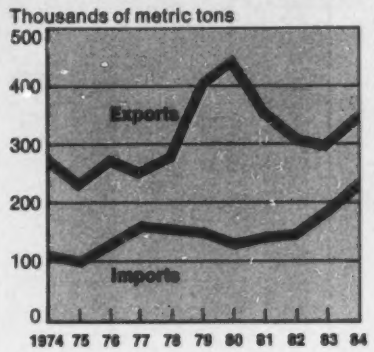
One observer who takes a distinctly world view of the business is Uniroyal's Eisenberg. He estimates the world rubber processing chemical market at 550,000 metric tons. Of this, North America, Western Europe, and Eastern Europe each consume 25%, and Asia 15%. On this worldwide scale, Uniroyal views itself as truly a chemical company, with only 10 to 15% of its production used captively and 85 to 90% destined for the merchant market.

Such a global competitive stance in rubber-processing chemicals makes sense when considered in conjunction with changing world patterns of rubber consumption. Predicasts, a Cleveland-based business information research firm, notes that growth of tires and total rubber will slow to 1 to 2% annually in the U.S. and Western Europe for the next 10 years. By contrast, yearly growth will be 7.2% in Mexico, 6.1% in Brazil, 4.6% elsewhere in Latin America, and 4.0% in Asia exclusive of China and Japan.

Predicasts analysts ascribe the low future growth rates in the U.S. and Western Europe to increasing penetration of radial tires, reduction in the number of miles driven, lower demand for vehicles, and penetration of plastics into nontire rubber applications. Moreover, shifts of auto production to countries like South Korea and Taiwan will increase demand for rubber chemicals there while diminishing it in western countries.

Moreover, Predicasts adopts a bright view of long-term economic growth by developing countries of Latin America and Asia, a resulting high demand for commercial vehicles, high per capita rubber con-

Exports of synthetic rubber maintain lead over imports



Source: Rubber Manufacturers Association

Worker taps rubber tree at Firestone Liberia plantation

Specialty rubber applications include insulation on copper tubing for air conditioners (above), large-diameter hose (left) in oil drilling

sumption, and high population growth rates in those regions, to achieve relatively large increases in rubber consumption. Again, the high proportion of growth in manufacturing to overall economic growth in developing countries leads Predicasts analysts to forecast a greater-than-usual growth in nontire rubber goods for industrial and consumer uses.

The Cleveland firm's optimistic outlook on Mexico is based on its oil and gas resources, its auto industry (General Motors, Ford, Chrysler, American Motors, Renault, Nissan, and Volkswagen), its tire industry (Goodyear, Uniroyal, and joint ventures of Goodrich and General Tire & Rubber), a mostly self-sufficient synthetic rubber industry, and the high priority the Mexican government has given to rubber. Predicasts is aware of the current social and economic ills of the country and the worldwide overcapacity of oil production, but remains cautiously optimistic over the long term.

Predicasts ascribes Brazil's strength to a reliance on motor vehicles for transportation in a country poor in railroads, coastal shipping, and air transport. The nontire rubber industry also is healthy, because of Brazil's industrial and consumer goods expansions. Also on the plus side, Brazil remains an important producer of natural rubber, has built up a synthetic rubber industry, has a large, self-sufficient tire industry, and has a focus on exports and trade barriers to imports. On the debit side, the country is beset by economic problems, has no competitive edge in synthetic rubber production, and is plagued by tree diseases in its efforts to expand rubber plantations. □

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